THE STATE AGRICULTURAL COLLEGE
OF COLORADO

THE FORTY-SIXTH ANNUAL REPORT

—OF—

The Colorado Agricultural Experiment Station

FOR THE FISCAL YEAR 1932-33

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The Colorado Agricultural College

FORT COLLINS, COLORADO

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FINANCIAL REPORT OF THE EXPERIMENT STATION

For the Year Ending June 30, 1933

DR.	Hatch Fund	Adams Fund	Purnell Fund	State Mill Levy Fund	Special Fund	Pure Seed Fund	Irrig. Cash Fund	Total Funds
Balance July 1, 1933	.....	.....	.....	$19,864.30	($735.58)*	$ 8,000.00	$ 84.03	$27,212.75
From the Treasurer of the United States as per appropriations for the fiscal year ending June 30, 1933, under acts of Congress approved March 2, 1887 (Hatch Fund), March 16, 1906, (Adams Fund), and February 24, 1925 (Purnell Fund).	$15,000.00	$15,000.00	$60,000.00	.....	.....	.....	.....	90,000.00
Other sources than the United States	.....	.....	.....	84,787.57	18,204.28	.....	680.00	103,671.85
	$15,000.00	$15,000.00	$60,000.00	$104,651.87	$17,468.70	$8,000.00	$764.03	$220,884.60
CR.								
To Salaries	15,000.00	15,000.00	43,166.26	43,182.93	.....	4,600.77	465.00	121,414.96
Labor			6,783.21	14,493.36	1,259.44	2,638.05	.....	25,174.06
Stationery and office supplies			223.13	1,267.80	64.28	88.57	0.80	1,644.58
Scientific supplies, consumable			1,521.45	1,873.10	2,381.63	51.50	.....	5,827.68
Feeding stuffs			533.51	4,543.67	92.47	.....	.....	5,169.65
Sundry supplies			314.52	1,663.66	914.16	45.40	4.31	2,942.05
Fertilizers			278.79	0.75	.....	.....	.....	279.54
Communication service			32.47	1,049.66	209.11	111.57	3.90	1,406.71
Travel expense			1,984.70	4,823.79	498.13	364.83	135.38	7,856.83
Transportation of things			205.20	1,692.21	64.52	.....	.....	1,961.93
Publications			1,328.04	3,147.50	23.00	.....	.....	4,498.54
Heat, light, water, power			15.70	3,744.85	211.14	.....	.....	3,971.69
Furniture, furnishings and fixtures			525.19	1,355.62	88.34	1.45	.....	1,970.60
Library			52.46	678.88	9.00	7.95	.....	748.29
Scientific equipment			2,015.34	1,570.48	38.58	28.42	.....	3,652.82
Livestock			.....	48.00	.....	.....	.....	48.00
Tools, machinery and appliances			700.93	1,920.03	512.34	23.49	.....	3,156.79
Buildings and land			241.13	2,533.25	223.00	.....	.....	2,997.38
Contingent expenses			77.97	516.73	39.39	38.00	.....	672.09
	$15,000.00	$15,000.00	$60,000.00	$90,106.27	$ 6,628.53	$8,000.00	$659.39	$195,394.19
Balance on hand June 30, 1933	.....	.....	.....	14,545.60	10,840.17	.....	104.64	25,490.41
Grand Total	$15,000.00	$15,000.00	$60,000.00	$104,651.87	$17,468.70	$8,000.00	$764.03	$220,884.60

(*) Overdraft

Letter of Transmittal

To His Excellency, Edwin C. Johnson, Governor of Colorado:

In accordance with the law of Congress establishing Agricultural Experiment Stations, I have the honor to transmit the Forty-Sixth Annual Report of the Colorado Agricultural Experiment Station for the federal and state fiscal years July 1, 1932, to and including June 30, 1933.

E. P. Sandsten, Director.

Fort Collins, Colorado
July 1, 1933.

Report of the Director

To the President and State Board of Agriculture:

This brief report covers the main activities of the Experiment Station during the fiscal year ending June 30. 1933.

The writer assumed the office of director on September 1, 1932, and has carried out the program as formulated by his predecessor.

During the year, Dr. Walter G. Sackett, head of the Bacteriological Section, resigned to engage in private work. The investigations of this section have been transferred to the Bacteriological Department of the college, under Dr. I. E. Newsom. Mr. D. A. Wigle, testing engineer in the Civil and Irrigation Engineering Section, also resigned to accept a teaching position elsewhere.

Some changes in the general policy of the station have been made so as to meet the demand from different farm groups in the state, and to place the station more in line with the economic conditions, but its fundamental policy has not been changed.

The sub-station work which has been greatly extended, has proved very valuable to the sections where these stations are located. The sub-stations enable us to put into actual practice types of farming that the station is advocating and which experiments have proved to be successful. Experiments dealing with vegetable crops and fruits are carried on at these sub-stations, thus making it possible to test out the different varieties over a wider territory and making sure of their adaptability to the different sections of the state. These sub-stations are located in the most promising commercial-producing regions in Colorado.

The Avon station has served a very useful purpose, not only in demonstrating a profitable type of mountain farming but also in the development of potato varieties and hardy vegetable crops.

The work at the Rocky Ford sub-station that was recently taken over by the Horticultural Section, has been planned so as to be of the greatest help to the seed truck-crop farmers in the Arkansas Valley. The major lines of work carried include the development of better seed stock, greater diversification in crops, soil management, crop rotation and extensive planting of small fruits to determine the best varieties for the valley. A large vineyard for testing new and old varieties of grapes has been planted. Extensive Valencia-onion breeding and selection work to improve the yield and quality is being carried on, along with experiments in the curing and storage of onions, as well as control of onion diseases and insects. The work at the sub-station

is closely tied up with the vegetable breeding and selection program at the main station at Fort Collins.

The experimental work in Agronomy at the Akron Station is carried under a cooperative agreement with the federal government. Trial plantings of forage plants adapted to the plains area are maintained, the new varieties are tested, and the information furnished to the farmers.

The Animal Investigations section is also conducting feeding experiments at Akron to work out a livestock program for the plains area, using the native feeds as far as possible. It is believed that the future of plains farming is dependent upon greater diversification of crops grown, and sufficient livestock to maintain soil fertility.

The fruit station at Austin is doing excellent work for the tree fruit industry of Western Colorado. While the station has served as a demonstration orchard for a number of years, extensive planting of new varieties to test their commercial values has been made. A trial vineyard of American and European varieties was planted 5 years ago. All the American varieties have done well, and four or five European varieties can be grown with slight winter protection. The experimental work has, in the main, been confined to cover crops, soil management and fertilizer. With the general depression in the fruit industry and the resultant discouragement among the growers, it is very important that the work at Austin be maintained at a high standard.

AGRONOMY

STUDIES IN THE CONTROL OF BACTERIAL WILT AND WINTER-KILLING OF ALFALFA.—On the Experiment Station plots, all of which are thoroly inoculated with the alfalfa wilt organism, *Aplantobacter insidiosum,* all of the so-called resistant varieties of alfalfa, no matter what origin, were killed in the trial experiments. Of those put in adjoining counties on selected farms, Ladak was shown to be more resistant than any other variety tested. The only practice followed which permitted the stand to be carried thruout was that of failing to cut the third cutting. In each case the plats so treated came thru with fairly good stands. The reduction in yield amounted to about .75 ton per year, but it enabled the crop to survive where it perished under all other conditions. Apparently the only hope for a non-resistant variety is in breeding work and possibly cultural methods. (*Purnell and State funds*).

IMPROVEMENT IN SOIL-PLAQUE METHOD OF DETERMINING MINERAL SOIL DEFICIENCIES.—For some time it was apparent

that the correct interpretation was not always given by the soil-plaque testing for fertility needs. In 1932, 93 fields were obtained whose history was known. These were high-yielding fields on which there was a record of actual phosphate field application and returns. The results showed that the soil plaque, or bacterial method, gave the correct interpretation on the low-yielding fields which were deficient by field trails. On the high-yielding fields, however, the bacterial method gave only about an 8 percent correct interpretation. In the laboratory, a modification of the method used by Das in India was developed. This method, applied to both the low and high-yielding fields, gave a 90 percent correct interpretation of all soils tested. The results were combined and published in Technical Bulletin No. 2. (*Purnell fund*).

THE CONTROL OF EXCESSIVE SOIL NITRATES IN THE ARKANSAS VALLEY.—The results of 10 years' work on this problem are somewhat different from those previously reported. These studies bring out the fact that nitrates accumulate in damaging quantities only under special conditions, such as an impervious soil which does not permit movement thru the soil profile, a high water-table which is more or less stagnant, or seepage conditions, and when these conditions prevail other salts are always present in excessive quantities. The so-called nitrate spots are salt spots in which many ions are working toward the group effect of damage to the soil or crop growth on that soil. The problem of control in such damaging locations becomes a problem of removing the cause, whether that be an impervious soil, a high water-table, or seepage. The work has gone far enough to show that more nitrates are produced in the soil than can be accounted for thru the use of irrigation water. (*Purnell and State funds*).

GENETIC STUDIES AND LINKAGE RELATIONSHIPS IN BARLEY.—Dr. Robertson's studies on linkage relationships are outstanding. These linkage studies are throwing light on barley inheritance and the possibility of producing new types of barley. Some very desirable barley characteristics are linked with some others that are very undesirable. In order to get the good characteristics to be inherited with certain other good characteristics, it is necessary for crossing-over to take place in order to break these linkage relationships. This is possible, but is a slow process. These facts throw light on the difficulty of some barley-breeding problems. (*Purnell and State funds*).

HIGH ALTITUDE CROPS.—Work on the studies with peas has gone far enough to enable publication on the subject. The studies have resulted in putting forward pea varieties which will give

much higher yields than those now in use; in some cases the average yields being doubled. (*State funds*).

PLAINS CROPS AND MANAGEMENT.—For several years, research has been conducted on corn. Three centers of seed production of Colorado 13 have been established: In Weld County, principally at Platteville, Larimer County at Fort Collins, and in the district about Colorado Springs. In yellow corn, the Raymond Condon strain (Colo. 13) still dominates in the northern regions. In the longer-season regions of the Arkansas Valley, other types come in. Special strains of Reed's yellow dent and Iowa Silvermine, developed by growers in that section, add to the number of varieties and increase total production.

Coss Sorgo developed at Akron by breeding, is a sorghum crop addition of unusual merit, and is increasing the standard of seed production and quality over much of the dryland region. (*State funds*).

ANIMAL INVESTIGATIONS

A COMPARISON OF PROTEIN SUPPLEMENTS IN BEET BY-PRODUCTS RATIONS FOR FATTENING CALVES.—The two-season series of tests show that .5 lb. of cottonseed cake is sufficient to balance a ration composed of grain, wet beet pulp and alfalfa hay when fed to calves. This is the common ration in use in sugar-factory districts, and is our standard ration against which other steer rations are checked. A test was also made of ground flaxseed as a protein supplement. It was shown that flaxseed compares very favorably with cottonseed cake as a protein supplement in the standard beet-pulp ration. (*Purnell and State funds*).

COMPARISON OF GRAINS FOR FATTENING CALVES.—Barley and wheat were compared with corn, the chief object of the series being to compare wheat with barley and corn. Barley produced good and cheap gains, but there is greater tendency towards grain bloat of the animals when barley is fed. (*State funds*).

RATIONS FOR FATTENING LAMBS AT AKRON.—The lambs receiving hog millet (Proso) fed with cane fodder and cottonseed cake, made as good gains as those fed corn, cake and fodder, but required one-third more cane fodder. (*State funds*).

BACTERIOLOGY

STUDIES IN THE CONTROL OF BACTERIAL WILT AND WINTER KILLING OF ALFALFA.—This is a cooperative project with the Agronomy Section. Experimental plots were planted 5 years ago at Longmont, Fort Collins and Greeley, but due to the different ways the plots were handled it was impossible to draw any con-

clusive results as to the relative merits of the different varieties. In a general way, Ladak and Cossack were among the best, and Grimm among the poorest. (*Purnell and State funds*).

THE PSYLLID YELLOWS OF POTATOES.—A great deal of time was given the past year to the true nature of the causal agent of so-called purple-top or psyllid yellows of potatoes. The cause of the malady is problematical, but it has been claimed by some workers to be due to a virus transmitted by an insect. Our work has dealt primarily with an attempt to establish or disprove some virus as a causal agent. After a very extensive study, both in the field and greenhouse, no evidence was obtained in support of a virus as a causal agent by following the methods ordinarily employed in the investigation of this class of diseases. (*Purnell and State funds*).

BOTANY

RANGE AND PASTURE IMPROVEMENTS.—During the winter, laboratory and greenhouse studies were made on the relation of surface and soil moisture to establishing seedling forage plants in the North Park hay meadows. The range forage nursery has been enlarged, with several favorable grasses selected for increase plots. Seeds of two species of Wallaby grass were received from Australia. This plant grows under extremely dry conditions in that country. Teff grass, an annual from Transvaal, has produced seed the past two seasons. These plants show possibilities for early spring growth, yield and vigor of establishment, along with other factors which may be important in range improvement. (*Purnell and State funds*).

TRUCK-CROP DISEASE STUDIES.—Spraying experiments on control of purple blotch of onions were continued during the past year; also work on a fusarium neck rot which was discovered in stored onions. Collar rot of tomatoes, which caused serious loss 2 years ago, is caused by the fungus *Alternaria solani.* The pathology, host relations and control of the disease were worked out. Use of clean stock from new or sterilized soil is the remedy for this disease. (*Hatch and State funds*).

DISEASES OF GREENHOUSE PLANTS.—*Fusarium dianthi,* the fungus causing carnation wilt, may travel up the stem as much as 14 inches. Cuttings from disease-free stock resulted in clean plants. This practice, together with ordinary sanitary measures, has made it possible to control the disease. (*State funds*).

WEED CONTROL.—Under this project, work on chlorates has been continued on bindweed, white weed, poverty weeds, Canada

thistle and Russian knapweed. New chemical treatments were tested and definite experiments on cultivation were included in last season's work. (*Purnell fund*).

SEED LABORATORY

In the laboratory, 2,957 samples were voluntarily submitted for examination, with tests made as follows:

Purity	2,559
Germination	3,507
Identification	18
	6,084

Two hundred ninety-eight samples were tested for The Seed Registration Service; 350 samples were tested in connection with comparative-longevity studies. Publicity work has taken the form of correct labelling of seeds thru the seed inspector. The quality of seeds carried into the state, as well as seeds distributed from one part of the state to another by trucks has been scrutinized.

STATE SEED INSPECTION.—Beginning with the seed season of 1930 a state-wide seed-inspection program was inaugurated, the seed inspector traveling by automobile and endeavoring to inspect the seed stocks of all dealers, merchants and elevators in all towns where seed was sold. As a result of the new inspection campaign, many dealers, and thru them many farmers, became acquainted with the Pure Seed Law for the first time, altho it had been in force since 1917. They also learned of the State Seed Laboratory with its facilities for testing seeds, and determining the germination, purity and weed content.

As a result of these efforts, there is a very noticeable difference in the manner in which seed is being handled by the majority of the dealers in the state at the present time, as compared with the manner in which it was handled when the inspection program was inaugurated 4 years ago. Analysis tags or labels are becoming common, and while they are not always all that is desired, they indicate a definite step in the right direction, and even where tags are lacking the dealer often has satisfied himself as to the quality of the seed, as indicated by the presence of a State Seed Laboratory certificate in the office.

It is interesting to note that of the 10 really serious noxious weeds which are causing concern in Colorado, only two are native to the United States. The others have been introduced from Europe and spread thruout our country, largely thru the agency of impure seeds.

One of the most serious problems which the state has had to

face in securing the observance of the Pure Seed Law is the traffic in seeds carried on by trucks. In some instances the truckers are not familiar with the law, know nothing about seeds, and care less. Their sole objective is to keep their trucks busy, and as a result large quantities of untested seed of poor quality and unadapted to Colorado conditions have been sold within the state for almost any price obtainable, in most instances being peddled directly to the farmers.

CHEMISTRY

DETERIORATION OF ALFALFA HAYS RESULTING FROM SUNSHINE AND STORAGE.—But one project is carried in this section, and that is about completed. It has to do with the deterioration of alfalfa hay resulting from rain. One of the phases of this project was a study on the curing and storage of alfalfa hay. It was found that to cure the hay it was best to leave it in the swath 1 day longer when using a common dump rake as compared with a side delivery rake. But 1 day longer in the sunshine may mean some loss of vitamins.

Some hay was dehydrated at the laboratory and the results seem to show a remarkably high content of vitamin A.

An interesting sample was obtained by passing freshly cut alfalfa thru a set of tinner's rolls. The rolls were so set that while the stems were crushed, juice was not wrung out of the plants. The crushed plants were placed on a canvas to the usual depth of a swath and the hay then dried in the bright sunshine. It dried in the very short time of 6 hours to about 20 percent moisture—the point at which most hay is stacked in Colorado. As it usually takes 3 to 4 days to dry to 20 percent moisture in the field, one can see what a saving this treatment would mean, not only in time but in vitamins, as both vitamins A and B are lost by exposure to sunshine. A preliminary test on this sample showed it to be superior to the dehydrated hay in vitamin A.

The question has arisen as to whether there is any difference in the vitamin content of the different varieties of alfalfa, so a few varieties—Cossack, Grimm and Turkestan—are being compared with the common alfalfa. So far the vitamin determinations have not been completed. (*Adams, Purnell and State funds*).

ECONOMICS AND SOCIOLOGY

AN ECONOMIC STUDY OF FARM ORGANIZATION AND MANAGEMENT IN THE GREELEY AREA.—Work on this project has been continued in the Greeley area. For the years 1922 to 1930, inclusive, the farms were approximately 160 acres in size. The feeding operations added $506 per farm unit to the income that

might otherwise have resulted from selling farm-raised feeds at prevailing market prices. During the year 1932, 17 out of 20 farmers reported cash receipts in excess of cash farm expenses. These men were unable to meet imputed charges for depreciation, interest on owner's equity and wages of management, except in part, but were able to pay their cash expenses and had a reasonable residue to meet personal expenses. Data from this project have been in frequent demand in obtaining more favorable adjustments for the agricultural industry in railroad freight hearings. (*Purnell fund*).

A STUDY OF COSTS AND METHODS OF PRODUCING CATTLE AND SHEEP ON THE RANGE IN COLORADO.—During the 3-year period ending with 1931, records have been assembled from approximately 20 ranches in the North Park area. The study has shown wide differences in the conditions that prevail on the mountain ranches in this region, in contrast with the situation under which the cattle are produced in other sections of the state. The records from these ranches have aided in setting up the minimum requirements for wintering range cattle, and they have provided some constructive suggestions with respect to organization plans looking toward a better-balanced business. (*Purnell fund*).

RURAL SOCIAL AGENCIES IN COLORADO — CLASSIFICATION AND EVALUATION.—One section of the report relating to rural social organizations in Colorado has been completed. Attention has also been given to a revision of the manuscript dealing with the social status of Spanish-speaking people in Colorado. The case work of this study represents the findings from some 300 Spanish families working upon farms in different sections of Colorado. (*Purnell fund*).

A STUDY OF TAXATION IN COLORADO.—Two phases of this study relating to county government have been completed during the year. The first attempts to explain and evaluate the methods of administering county government and handling county business. The second phase relates to the problem of county consolidation. The study points out the desirability of developing certain combinations in specific regions for the purpose of introducing and developing a more efficient county organization for regions with insufficient population to permit the efficient operation of the customary activities. (*Purnell and State funds*).

AN ECONOMIC STUDY OF LAND UTILIZATION IN NORTHWESTERN COLORADO.—This project was undertaken in 1926 in connection with the Division of Land Economics, U. S. Department of Agriculture. It was intended to show the settlers' progress in the newly homesteaded area of Northwestern Colorado, in con-

trast with the development that has taken place in some of the older settled areas in the same section of Colorado. Adverse price conditions, high transportation costs and a virtual collapse of the bank-institutions of the regions have caused untold suffering. Inexperienced homesteaders face rather severe difficulties under the new conditions of a semi-arid frontier, and many have been compelled to relinquish their claims. (*Purnell fund*).

A STUDY OF THE MAJOR TYPES OF COOPERATIVE ORGANIZATIONS OR ASSOCIATIONS IN COLORADO.—This study, covering the business years of 1929-30 and 1930-31, shows that practically all of these business units were in a favorable position, considering the type of organization and the trade conditions which prevailed during the period. Records have been assembled for the year 1931-32, and supplementary data obtained with reference to the income and expenses of these organizations during an unfavorable crop year. (*Purnell and State funds*).

CIVIL ENGINEERING

LIGHT ASPHALTIC ROAD SURFACES.—This project has been active thruout the year. Two hundred and twenty-nine tests on oiled-road samples have been made, the samples being taken from oil-graveled roads in different parts of the state. Two hundred and four cylinders have been made from gravel and three different road oils for the purpose of determining evaporation and absorption factors in the materials of the state used on oiled roads. Twenty-four have been tested to date. An experimental road section was constructed during July and August, 1932, on the Fort Collins-Ault highway. In this road the oil content was to vary from an over-rich mix to a very lean one. As expected, the experimental mixes failed. At some point between these extremes the economical percentage of oil for road purposes would be found. The road was laid in sections of 50 feet for each percentage of oil, and cost $662. Due to a number of unforseen difficulties, this experimental road section was not satisfactory. It is recommended that a roadway on the college campus be used for further experimentation along this line. (*State funds*).

MECHANICAL ENGINEERING

Due to the death of Mr. Fred Goetz in December, 1932, the work he was carrying was discontinued, except the operations of heat control in the campus buildings. This was carried on by Mr. James Larsen for the remainder of the season.

SUGAR-BEET MACHINERY.—The present live project in this section is the cooperative one with the U. S. Bureau of Agricultural Engineering, dealing with the testing and development of machinery for planting, fertilizing, blocking and harvesting of

beets. A plot of 10 acres has been rented and Mr. E. M. Mervine, of the bureau, has complete control of all phases of the raising of the beets on this plot. Complete costs of preparing the seedbed, planting, fertilizing, blocking, cultivating and harvesting will be kept, and these costs compared with those for hand operations. Machines of different makes are being tested to determine their adaptability to meet the conditions prevailing in this beet area. The results will be compared with those obtained for similar machines and their operations in other beet areas, (*State funds*).

ENTOMOLOGY

GRASSHOPPER CONTROL.—The summer of 1932 saw another severe outbreak of these pests, the most serious of which was in the lower Arkansas Valley. Experimental work indicated that salt is not necessary in the poison formula in areas having alkali soils. Amyl acetate is essential when beet syrup is used but adds nothing to the attractiveness when cane molasses is used; amyl acetate and beet molasses are fully as effective and cheaper than cane molasses; dried beet pulp has possibilities as a substitute for bran, but no other substitutes were found. (*State funds*).

THE RELATION OF THE POTATO PSYLLID *Paratrioza cockerelli* (SULC.) TO THE POTATO DISEASE KNOWN AS "PSYLLID YELLOWS."—Loss to the potato crop from the work of the tomato psyllid, *Paratrioza cockerelli* Sulc. was estimated at from 5 to 8 million bushels. A survey showed the pest to occur in all sections of the state. The early crop in Weld and Morgan counties was almost a complete failure, and the late crop not more than 25 percent of normal. In the San Luis Valley the yield was reduced from 40 to 60 percent in some fields. A bulletin on this subject giving control measures is being published. (*Purnell and State funds*).

CODLING-MOTH CONTROL BY MEANS OF AN EGG PARASITE.—Over 3,000,000 codling-moth egg parasites, *Trichogramma minutum* Riley, were reared in the experimental laboratory at Fort Collins and liberated in orchards on the Western Slope. Three different strains were used. It was found that unless a higher parasitism of first-brood eggs can be secured, this method of control will not be such that it can be recommended to the fruit growers.

A 12-acre orchard at Paonia was sprayed experimentally for the control of the codling moth, the main object being to test the series of schedules and materials that may not only give better control than the standard arsenate of lead, but make it easier for the fruit growers to meet the tolerance that has been

established on spray residue. The situation will be more complicated another year, due to the fact that the pure food and drug officials have recently established a tolerance of .014 grains of lead per pound of food. This will mean that arsenate of lead, by far the most important stomach poison for insects, must be largely eliminated from the spraying schedules. There is much need of work to develop substitutes for it. (*Purnell and State funds*).

GENERAL INSECT INVESTIGATIONS.—The eastern half of the state experienced last season the most severe outbreak of the alfalfa webworm, *Loxostege commixtales* Walker, on record. Many thousands of acres of sugar beets, truck crops and new seedings of alfalfa were destroyed. Spraying with paris green on sugar beets, and arsenate of lead on truck crops proved the most effective control, but trap furrows and oil barriers proved very effective when migrations took place.

Several hundred acres of head lettuce were destroyed in the mountain areas by the cabbage looper and the alfalfa webworm. This calls for new controls, as the standard arsenicals leave a residue above the tolerance permitted on food products. Various tests were made to find suitable controls, but no satisfactory recommendations can be made. The contact materials which do not leave objectionable residues are too inefficient and expensive to be practical. (*State funds*).

HOME ECONOMICS

BAKING OF FLOUR MIXTURES AT HIGH ALTITUDES.—A study of egg-white structure was the first step in the approach to the project from a physical chemistry standpoint. Viscosity and surface-tension studies, together with the effect of six different factors on foam structure, have been studied in detail and the results expressed in graph form. Micro-photographic reproductions have been secured in many cases. The six factors referred to include:—Barometric pressure, beating time pH (acids and acid salts), salt (NaCl), and age of egg.

Dr. Barmore, in charge of the investigation, states:

From these studies and the literature, we are able to draw the following picture of egg-white foam:—It is an emulsion of air in liquid, and at the air-liquid interface there is a concentration of the protein which coagulates, forming a tough skin about one molecule thick, and thus permitting the emulsion to be stable for some time. The lighter the foam, the less the wall thickness, and there seems to be a point at which the two surfaces are connected by what appear to be long chains of albumin molecules (possibly coagulated.) This gives to the foam the quality of dryness. The egg-white foam is not, however, permanently stable because the viscosity of the liquid

contained between the air-liquid interfaces and the dimensions of these spaces are such that the liquid drains out and the coagulated surface layers of protein break, allowing the air to escape.

The egg-white is composed of microscopic fibers of protein which make the viscosity very high. On beating, these fibers are cut or torn, producing a relatively low viscosity. This allows for the production of a highly dispersed foam, but at the same time the lower the viscosity the more unstable the foam produced. In fact, we have shown that the stability of our foam is a linear function of the viscosity of the egg-white drained from them.

On adding substances to the egg-white which decrease its pH, substances such as acids and acid salts, there is produced a change that is partly due to an increase in viscosity but largely due to some change produced in the nature of the protein. The result is a much more stable foam. It was at first thought that the acid combined with the protein formed a protein salt and that the properties of this protein salt, when concentrated and coagulated in the surface, were such as to produce the more stable foam. However, on analysis of a number of these foams, no increase of the acid radical in the surface layers could be detected.

There seems to be a critical point at which the viscosity becomes the major factor affecting the foam stability. When the amount of acid is such that this point of low viscosity is reached, the foam becomes less stable. As more acid is added, the viscosity decreases still more, the foam becoming more and more unstable.

Another phase of the problem undertaken was that of applying this foam study to a study of angel-food cakes. Not much progress has been made so far with this aspect of the investigation. It is assumed, however, that the reason it is necessary to add an acid, such as potassium bitartrate, to egg-white to produce a successful cake is explained by its effects on egg-white alone. It appears probable that the acid produces a more stable foam, thus allowing the temperature inside the cake to reach such a point that the protein is coagulated and the starch gelatinized before the breaking of the emulsion has proceeded far enough to produce poor cake volume or large holes. (*Purnell fund*).

HORTICULTURE

POD-PEA VARIETY AND SELECTION.—This project has been carried since 1927 and covers detailed records of 861 varieties of pod peas. At the present time a yield and earliness test on 25 of the outstanding varieties is being carried on, the work being entirely on the selection and improvement of varieties that are specially adapted to the shipping trade as a market pea.

The work with peas is carried both at the Avon High-Altitude Station and at Fort Collins. Growers of pod peas in the higher mountain valleys have been supplied with foundation seed stock from Avon which has an altitude of 7800 feet. This work

is of great value to growers as a source of high-quality pea seed from which they can grow seed for their own requirements. (*State funds*).

GARDEN POD BEANS.—This project has also been carried for several years, and summaries of yield and earliness and pod and plant characters on 150 American and European varieties are available. The results of this work furnish foundation information necessary for a bean-breeding program, as well as a basis of practical information to the growers. The investigation includes the improvement of bean seed stocks by individual plant-selection methods on the more important varieties. A few varieties have been cross-bred with the object of selecting a higher-yielding, better-quality pod from the progeny. (*Hatch and State funds*).

ORCHARD MANAGEMENT.—This work is carried on at the Austin sub-station in connection with the work of the State Horticulturist. A revised edition of Bulletin 250 on Orchard Management is now in press. A great deal of attention has been given the subject of cover crops, and it has been found that annual cover crops are much better suited to the requirements of peaches, apricots, plums, cherries and new plantings of all kinds of fruits which require more cultivation than to apples or pears. Commercial fertilizers have not been tested long enough to justify definite recommendations concerning their value or effect on quality and yield. (*State funds*).

GRAPE GROWING WITH SPECIAL REFERENCE TO EUROPEAN VARIETIES.—This project has been under way for 6 years, and some very satisfactory yields have been secured on many of the standard California varieties. Some were not adapted to our short growing season, but others, such as Tokay, Black Hamburg and Muscat have been grown successfully with winter protection. (*State funds*).

GENERAL VARIETY TESTS OF APPLES, CHERRIES, PLUMS, APRICOTS, PEACHES AND PEARS FOR DELTA COUNTY.—This project includes the planting and testing of newer and more promising varieties of all kinds of fruits. This planting makes it possible for fruit growers to visit the orchard and see for themselves how the new varieties perform under their own conditions. Considerable work is now being carried on red varieties of apples, with many new sports and a few crosses included in this trial. A good deal of attention is being given to testing pear varieties for resistance to fire blight. One of the most promising new varieties which shows considerable resistance is the Gor-

ham. It is 1 to 2 weeks later than the Bartlett and is about the same type of fruit. (*State funds*).

POTATO VARIETY TESTING AND IMPROVEMENT BY SELECTION.—About 500 seedlings are under test at the Avon sub-station, being mostly secured from seed obtained from England and Scotland. For 1933 the plantings include seedlings from the Peachblow and Brown Beauty varieties.

The selection work on the commercial varieties of potatoes in the state has made satisfactory progress, and foundation stock of some of the better strains has been released to growers for increase. Sufficient seed of the dark-red Peachblow was distributed to growers last year to produce two carloads of seed stock. (*Hatch and State funds*).

DEVELOPMENT OF A TIPBURN-RESISTANT VARIETY OF HEAD LETTUCE.—The results of preliminary work have already been published, which was necessary before a breeding program could be undertaken. There are now some four crosses in the F_2 generation which have been made between the tipburn-resistant varieties and the commercial New York No. 12. There are also some 15 plant lines on hand from selections and crosses made. Comparative strain trials have been conducted for many years on all of the commercial head-lettuce strains so that growers may be informed of the better new strains, and these trials have also given us information on the tipburn resistance of the new types. The plant breeders have also been concentrating their work on the problem of tipburn resistance and have cooperated with the department by sending in their pure line resistant stocks for trial at the station. There are now available some fine strains which show high resistance but need to be selected further to improve head characters. (*Purnell and State funds*).

SPANISH-ONION BREEDING WORK.—Satisfactory work has been done in the selection of improved strains of the Sweet Spanish onion varieties and in the cross breeding of varieties more resistant to thrip injury and storage rots. Improvement by selection methods has, so far, shown more rapid progress and the section has several good strains that are better in size, skin color and keeping quality in storage than the commercial strains of Sweet Spanish onions. (*Purnell and State funds*).

ONION CURING AND STORAGE.—Various methods of curing and handling the crop have been tried as a means of reducing storage rot losses. So far, the most promising method of curing has been shown to be that of curing bulbs for a longer period in the field before topping. Delayed topping of onions after pulling

has consistently reduced storage rot losses by more than 50 percent when compared with onions stored the first day after pulling. (*State funds*).

RASPBERRY CULTURE IN COLORADO.—The work done the past year was on black raspberries. The fruiting habit is being investigated from a histological basis, and the effect of different pruning methods on yields. This past winter the black raspberry canes were winter-killed, even tho protected by 2.5 feet of soil covering, so very little work can be devoted to this study during the coming growing season. (*Purnell and State funds*).

GENERAL VEGETABLE CROP INVESTIGATIONS.—This work included planting and comparison of new vegetable varieties secured from all over the United States, and the improvement by individual plant selection of the more important commercial varieties. The work is carried on at all three of the sub-stations and the results have been used as a basis for making definite recommendations on vegetable varieties that are suitable for specific uses in Colorado.

At the present time, seed-selection work has been centered on Giant Pascal celery, sweet corn for canning, and testing of cauliflower and cabbage seed stocks. There is also some miscellaneous work on crossing tomato varieties and testing hybrid sweet corn. (*State funds*).

IRRIGATION INVESTIGATIONS

MEASUREMENT OF WATER.—The use of the Parshall measuring flume still continues, and within the past few months one 12-foot and several 20-foot flumes have been constructed in the South Platte River Valley. At the present time it is estimated that probably 2,500 flumes of various sizes are now in use in Colorado, and the Parshall measuring flume is also being very generally used in sewage practice. Colorado Springs is using such a flume successfully, and reports have been received that extensive installations are being made on sewage systems in many eastern cities.

The investigation on current meters has been completed and a report issued. (*Hatch and State funds*).

EVAPORATION.—The work on evaporation from free-water surfaces has been closed and work suspended on the evapo-transpiration studies. A report covering the results of the past 4 years on this latter study has been prepared. In this study, outstanding results have been discovered in connection with sweet clover. It was determined in the season of 1932 that plants grown in a tank 2 feet in diameter consumed about 4.5 times as much water as would be observed from a free-water surface. The

maximum use in 1 day by the sweet clover was found to be about 2 inches of water depth from the soil surface. (*State funds*).

METEOROLOGY.—The usual information on weather conditions has been supplied daily to the local press. Early in the spring it was feared that the water supply for the year would be below normal. However, during April and May, heavy rains brought the precipitation up to practically normal. In the Poudre River Valley, it is believed that the storage reservoirs will have more than 75 percent of their normal capacity. (*State funds*).

PUMPING FOR IRRIGATION.—Field work has been done in the inspection of new irrigation wells, and advice given as to the proper type of well and pumping equipment needed. As a result, more efficient pumping plants are being installed. Studies have been made in the laboratory on the percolation of water thru various types of sand, where these samples have been taken from wells now in operation. It is proposed to study further the percolation into wells by means of laboratory experiments. (*State funds*).

DESIGN AND INVENTION OF APPARATUS.—For about 2 years considerable attention has been given to the development of vortex-tube and riffle-deflector sand traps. During the season of 1932, a riffle-deflector sand trap was installed in the Wanamaker Ditch near Golden. Its operation was considerably handicapped because of the large amount of debris carried in the ditch from Clear Creek. Early in the spring of 1933, the riffles were removed from the trap and the structure provided with two vortex-tubes, one having an angle of 45 degrees to the axis of the structure and the second one normal, or 90 degrees. These tubes outletted into a common sluiceway back to the creek. A recent inspection showed that the sluiceway was completely filled with sand. An attempt was made to dislodge this deposit by using a 2 second-foot flow, and it was discovered that these tubes were taking up more sand than could be disposed of. No tests have been made as to their efficiency, but it is believed that this type exceeds the efficiency of the former riffle-deflector installation.

Vortex-tube installations have been made on a ranch near Colorado Springs and on the Buffalo Canal, east of Lamar.

A model on a 1:10 scale has been constructed at the laboratory and tests made towards a possible installation on the Fort Lyon Horse Creek flume in the Arkansas Valley. This canal has a maximum capacity of more than 1,500 second feet. (*Hatch and State funds*).

PATHOLOGY

SHEEP LOSSES IN FEEDLOTS.—Sore mouth is one of the commonest diseases in feedlot lambs and has been recognized ever since the feeding industry started. A very thoro study was made by the United States Department of Animal Industry many years ago, and the disease was then regarded as bacterial and caused by *Actinomyces necrophorous*. Studies the past year showed that the primary cause is a filterable virus, and that *Actinomyces necrophorous* must be considered as a secondary invader. (*Hatch and State funds*).

COCCIDIOSIS IN CATTLE.—This is a serious malady that is increasing in seriousness, and altho the outbreaks for the past 4 years have been tabulated, that of last year gave the greatest percentage of loss yet observed. It is quite probable that it will be necessary to return to first principles and turn the affected lambs out where they can run over a wide area, thereby preventing transmission of the disease. Eight lots were tabulated during the last season, comprising nearly 19,000 head, with a morbidity of 22 percent and mortality of approximately 6 percent. This is about twice the mortality seen in previous years. (*Purnell and State funds*).

DEATH LOSSES IN LAMBS ON HEAVY GRAIN FEED.—The work was largely concerned with the filtration of intestinal contents of affected lambs and the determination of toxicity. Cultures were also made from the intestines with a view of determining what spore-bearing anaerobes might be present that could be responsible for the toxic condition. Further investigations must be had before any definite results can be published. (*Purnell and State funds*).

CONTAGIOUS ABORTION.—The herd at the U. S. Veterinary Hospital at Las Animas, as well as that at the college, is clean. There was one reactor in the college dairy herd for the first time since 1924. This proved to be a purchased animal that had contracted the disease from other purchased animals while being held in quarantine. Since this animal did not abort in the clean herd, it is not likely that her presence will prove serious. (*Hatch and State funds*).

GENERAL DISEASE INVESTIGATIONS.—In the last report, there was mention of an outbreak of blackleg in sheep following shearing, in which there was a loss of 145 animals out of 2,000. Since that time another traumatic outbreak occurred at Pueblo. A knife that had been used the day before in making a post-mortem examination on a calf dead of blackleg, was used for

castrating approximately 250 male lambs and for docking about the same number of ewe lambs. Following this, 100 of the buck lambs died and 10 of the ewe lambs.

Encephalomyelitis (KANSAS HORSE DISEASE). — Commencing in August, and continuing thru September and into October, the state experienced its third large outbreak of this disease. The affected areas were the Platte, Arkansas and San Luis Valleys. Approximately 1000 or 1200 horses were affected, with a mortality of about 36 percent. (*State funds*).

SWINE ERYSIPELAS.—While few cases of this disease have been found in the state in previous years, it was not realized that it was a serious problem to the swine industry until this summer. It has occurred in several areas in the eastern part of the state and is becoming of great importance. For this reason it is believed to warrant a more thoro study, and a project has been written up with a view of determining the means of spread and some manner of control. (*Purnell and State funds*).

BACILLARY WHITE DIARRHEA.—Because of the increase of the whole-blood test by owners of chickens, few birds were tested during the past year. Diagnostic service is being continued, however, in order that an accurate determination of the disease in baby chicks may be made. (*State funds*).

VETERINARY MEDICINE

ANIMAL DISEASES.—This is the only project carried in this section. It is general in nature and contemplates incidental investigation of disease outbreaks, and cooperation with the section of animal pathology and other agencies in animal-disease control.

An informational bulletin dealing with practical measures for control of the abortion disease awaits publication. (*State funds*).

PUBLICATIONS

REGULAR BULLETINS		EDITION
298	Principles of Making Fruit Jellies (Rvd.) by N. E. Goldthwaite. 28 pages	2,500
390	A Comparison of the Soil-Plaque Method with the Neubauer and Hoffer Cornstalk Methods for Determining Mineral Soil Deficiencies, by Laura C. Stewart, W. G. Sackett, D. W. Robertson and Alvin Kezer. 64 pages	3,000
391	Red-Clover Pollination by Honeybees in Colorado, by Roy G. Richmond. 24 pages	3,000
392	Soybeans Under Irrigation in Colorado, by D. W. Robertson, Alvin Kezer and G. W. Deming. 24 pages.	3,000

393 Thermostatically Controlled Master Valves as Heat Controllers for Buildings, by F. E. Goetz (deceased). 24 pages ---------- 1,500

394 Profits from Winter Feeding in Northern Colorado, by R. T. Burdick and H. B. Pingrey. 76 pages. ---- 2,000

395 Colorado Dryland Fattening Rations for Lambs, by H. B. Osland, E. J. Maynard and J. F. Brandon. 20 pages ---------- 3,000

396 Colorado Dryland Fattening Rations for Swine, by E. J. Maynard, H. B. Osland and J. F. Brandon. 20 pages ---------- 2,500

397 Operating Practices of Farmers' Cooperative Elevators in Colorado, by D. N. Donaldson and P. V. Hemphill. 64 pages ---------- 2,000

398 State and Local Tax Revision in Colorado, by G. S. Klemmedson. 124 pages ---------- 3,000

399 The Alfalfa Weevil in Colorado, by J. H. Newton. 20 pages ---------- 1,500

400 Potato Flea-Beetle Control, by L. B. Daniels. 32 pages ---------- 1,500

TECHNICAL BULLETINS

1 The Effect of a Lethal in the Heterozygous Condition on Barley Development, by D. W. Robertson. 12 pages ---------- 1,000

2 Comparison of Methods for Estimating Available Phosphorus in Alkaline Calcareous Soils, by R. D. Hockensmith, Robert Gardner and James Goodwin. 24 pages ---------- 2,000

3 The Rating and Use of Current Meters, by Carl Rohwer. 124 pages ---------- 1,500

4 Studies on Changes in Vitamin Content of Alfalfa, by Earl Douglass, J. W. Tobiska and C. E. Vail. 64 pages ---------- 1,500

PRESS BULLETINS

78 Ration Experiments with Calves, by Geo. E. Morton and H. B. Osland. 12 pages ---------- 3,000

79 Feedlot Fattening Rations for Lambs, by Geo. E. Morton and B. W. Fairbanks. 16 pages 2,500

80 Dryland Fattening Rations for Lambs, by Geo. E. Morton, H. B. Osland and J. F. Brandon. 12 pages -- 2,500

81 Fattening Rations for Hogs, by Geo. E. Morton, H. B. Osland and J. F. Brandon. 16 pages ---------- 2,500

REPORTS

Forty-fifth Annual Report of the Colorado Experiment Station for the Fiscal Year 1931-32. 64 pages 1,500

JOURNAL ARTICLES CONTRIBUTED BY THE EXPERIMENT STATION

The Effect of Removal of Tassels on Yield of Corn. W. A. Leonard and T. A. Kiesselbach. American Society of Agronomy, V. 24:7, July, 1932.

Effect of Pollen Source upon Grain Yield of Corn. W. A. Leonard and T. A. Kiesselbach. American Society of Agronomy, V. 24:7, July, 1932.

Inheritance in Barley, D. W. Robertson. Genetics, V. 18:2, March, 1933.

Germination of Seed of Farm Crops in Colorado after Storage for Various Periods of Years. D. W. Robertson and Anna M. Lute. Journal of Agricultural Research, Vol. 46:5, March, 1933.

Photopheriodism and Chrysanthemum Production, by E. J. Starkey. Science, N. S., Nov. 28, 1932.

Taxation in Colorado, by G. S. Klemmedson. The Colorado School Journal, Vol. XLVII, May, 1932, No. 9; Vol. XLVII, June, 1932, No. 10, p. 22.

Present Trends of Lamb Feeding in Northern Colorado, by H. B. Pingrey, Journal of Farm Economics, Vol. 15, No. 3, p. 557.

The Net Gain During the Last Decade in Codling-Moth Information as indicated by experience under conditions especially favorable to the insect, by Geo. M. List. Journal of Economic Entomology, Vol. 26, No. 2, April, 1933.

Evaporation from Different Types of Pans, by Carl Rohwer. Proceedings of American Society of Civil Engineers, Vol. 59:2, February, 1933.

Effect of Altitude on Evaporation, by Carl Rohwer. Cornell Civil Engineer, Vol. 41:6, March, 1933.

Evaporation from Salt Solution and from Oil-covered Water Surfaces, by Carl Rohwer. Journal of Agricultural Research, Vol. 46:8, April 15, 1933.

Further Observations on the Control of Contagious Abortion by Means of Blood Testing and Segregation, by I. E. Newsom and Floyd Cross. American Veterinary Medical Association Journal, Vol. 81, p. 195, 1932.

Blackleg in Sheep due to Shearing, by I. E. Newsom and Floyd Cross. Veterinary Medicine, Vol. 28:1, p. 16, 1933.

Encephalomyelitis of Horses in Colorado, by I. E. Newsom. Veterinary Medicine, Vol. 28:4, 1933.